Claims

What is claimed is:

1. Method for regulation tree construction comprising the following steps:
   (a) Input a decision tree;
   (b) Input a set of training samples;
   (c) Determine statistics from the training samples for at least one non-terminal node;
   (d) Determine statistics from the training samples for at least one terminal node.
   (e) Select regulation parameters

2. The method of claim 1 wherein the statistics for at least one non-terminal node include mean distance.

3. The method of claim 1 wherein the statistics for at least one non-terminal node include distance standard deviation.

4. The method of claim 1 wherein the statistics for at least one terminal node include the likelihood value for a class.

5. A regulation tree application method comprises the following steps:
   (a) Input a sample;
   (b) Determine the likelihood values for at least one non-terminal node;
   (c) Determine the likelihood value for a branch to at least one terminal node;
   (d) Determine the confidence value for at least one class.

6. The method of claim 5 wherein the likelihood values for at least one non-terminal node comprises a likelihood value for descending through the left branch and a likelihood value for descending through the right branch.

7. The method of claim 5 wherein the confidence value for a class c is determined by the following formula:

$$Confidence_c(X_{input}) = \sum_{j \in ter\min al\_nodes} \prod_{s \in branches\_to\_j} L^{s}(X_{input}) L^{j}_{\text{class\_c}}$$

8. An automatic tree regulation method comprises the following steps:
   (a) Determine the projected tree accuracies for a plurality of depths and a plurality of regulation parameter values;
   (b) Select the optimal depth that yields the highest projected tree accuracy;
   (c) Use the optimal regulation parameter value for the optimal depth

9. The method of claim 8 wherein the projected tree accuracy is determined by the following steps:
   (a) Construct a regulation tree up to a given depth;
   (b) Determine the projected tree accuracy;
   (c) Determine a regulation parameter value based on projected tree accuracy.

10. A regulation tree terminal node update learning method comprises the following steps:
    (a) Input a training sample;
    (b) Input the true class of the training sample;
    (c) Classify the input training sample using a crisp decision method to determine its associated terminal node;
    (d) Update terminal node statistics

11. The method of claim 10 wherein the terminal node statistics include N^n and N_c^n.

12. A regulation tree non-terminal node update learning method comprises the following steps:
    (a) Input a training sample;

(b) Input the true class of the training sample;

(c) Classify the input training sample using a crisp decision method to determine its association with at least one non-terminal node;

(d) Update non-terminal node statistics.

13. The method of claim 12 wherein the non-terminal node statistics include mean distance and the distance standard deviation.

14. A regulation tree update learning method for new classes comprises the following steps:

(a) Perform new regulation tree construction;

(b) Perform a compound tree update.

15. The method of claim 14 wherein the new tree construction further comprises the following steps:

(a) Input at least one sample from a new class;

(b) Check to confirm the sample size is greater than the minimal required sample size for the new class;

(c) Construct a new compound tree for all existing classes and the new class.

16. The method of claim 14 wherein the compound tree update further comprises the following steps:

(a) Input a new sample and its class;

(b) Update all trees trained to include the input class.

17. A compound tree application method comprises the following steps:

(a) Input a sample to be applied;

(b) Apply the sample to all trees;

(c) Combine the results from all trees.

18. A regulation tree pruning method comprises the following steps:

(a) Input a set of training samples;

(b) For a non-terminal node of the tree having two descending terminal nodes, determine the accuracies for identical training samples under two separate nodes or combined node conditions;

(c) If combined node accuracy is greater than the two separate node accuracy, prune the terminal nodes by combing the two terminal nodes and converting the associated non-terminal nodes into one terminal node.

19. The method of claim 18 wherein combing the two terminal nodes combines their sample counts.

20. A focusing tree construction method comprises the following steps:

(a) Input a set of training samples;

(b) Generate a new weight for each training sample;

(c) Generate a new tree using the new weight.

21. The method of claim 20 wherein generate new weight for each training sample further comprises the following steps:

(d) Determine the sample's discrimination merit;

(e) Derive the sample's weight update factor;

(f) Generate the new weight for the sample.

22. A focusing tree application method comprises the following steps:

(a) Input a sample to be applied;

(b) Classify the input sample by the first tree;

(c) If the classification reliability > threshold, use the current result as the final result and stop;

(d) Else, classify the input sample by the focus tree and use the new result as the final result.

23. The method of claim 22 wherein the classification reliability to an input sample X_{input} is calculated by

$$cr(X_{input}) = \frac{Confidence_{c1}(X_{input})}{Confidence_{c2}(X_{input}) + p}$$

24. The method of claim 20 is repeated multiple times to create multi-stage focusing trees.